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On asymmetric generalised *t* stochastic volatility models

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Abstract

In stochastic volatility (SV) models, asset returns conditional on the latent volatility are usually assumed to have a normal, Student-*t* or exponential power (EP) distribution. An earlier study uses a generalised *t* (GT) distribution for the conditional returns and the results indicate that the GT distribution provides a better model fit to the Australian Dollar/Japanese Yen daily exchange rate than the Student-*t* distribution. In fact, the GT family nests a number of well-known distributions including the commonly used normal, Student-*t* and EP distributions. This paper extends the SV model with a GT distribution by incorporating general volatility asymmetry. We compare the empirical performance of nested distributions of the GT distribution as well as different volatility asymmetry specifications. The new asymmetric GT SV models are estimated using the Bayesian Markov chain Monte Carlo (MCMC) method to obtain parameter and log-volatility estimates. By using daily returns from the Standard and Poors (S&P) 500 index, we investigate the effects of the specification of error distributions as well as volatility asymmetry on parameter and volatility estimates. Results show that the choice of error distributions has a major influence on volatility estimation only when volatility asymmetry is not accounted for.

Keywords: Generalised *t* distribution; Markov chain Monte Carlo; Stochastic volatility; Uniform scale mixture; Volatility asymmetry

1. Introduction

It has long been recognised that daily asset returns exhibit heavy-tailed behaviour, thus the normal distribution falls short of describing the empirical leptokurtosis. In the context of SV models, the Student-*t* and EP distributions are commonly used for the conditional returns. For example, Liesenfeld and Jung [21] compared a Student-*t* and a EP distributions to a normal distribution while Asai [3] extends the comparison to include a mixture-of-normal distributions. Choy et al. [13] and Wang et al. [29] use Student-*t* distribution in the analysis of SV models with a leverage effect. The successful application of these heavy-tailed distributions has motivated the search for more general and flexible distributions for the returns. In particular, Wang et al. [30] noted that the Student-*t* and EP distributions belong to a broader family of distributions known as the generalised *t* (GT) distribution and demonstrated its superior performance when the SV model is fitted to the Australian Dollar/Japanese Yen exchange rate. Although the GT distribution is able to adjust for the leptokurtosis of the non-normal asset returns, the SV model used in Wang et al. [30] does not account for the leverage effect, which is profound in stock market index data.

Asai and McAleer [6] defined asymmetry as the 'differential impacts of positive and negative shocks on the volatility'. A specific type of asymmetry is the leverage effect, which is typically modelled as a (negative) correlation between

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